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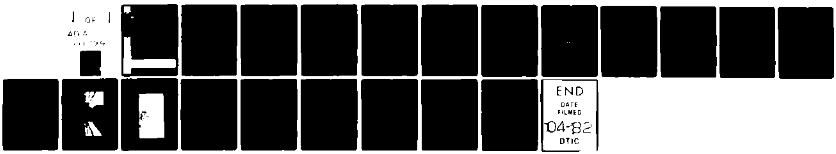

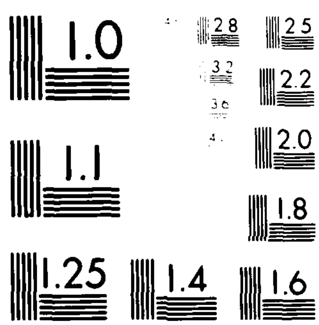

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Joseph R. Owen
Naval Training Equipment Center

November 1980

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Background and target image display luminance of the Visual Technology Research Simulator's wide angle screen was measured to define the performance levels used in conducting experiments and demonstrations of the Conventional Takeoff and Landing carrier simulations during 1978-80. Daytime display brightness is typically 4 footlamberts with a contrast ratio of 8:1. Nighttime display brightness is typically 1.5 footlamberts with a contrast ratio of 30:1. These display values are the result of system interaction of TV projector, optics and spherical screen characteristics and projection and viewpoint locations.

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PREFACE

This report provides support information for the Visual Technology Research Simulator located at NAVTRAEQUIPCEN, Code N-732, Orlando, Florida. It provides detailed equipment characteristics not usually included in experimental reports to supplement them for interpretation of results. This report deals with monochrome display brightness and contrast, and will be updated for color displays. Other reports giving detailed VTRS engineering characteristics will be published as data is generated and equipment modified. The next report will provide a complete description of system dynamics including visual and motion hardware time response and system time lag.

The author wishes to acknowledge the technical assistance provided by Walter S. Chambers in the preparation of this report.

SECTION I

INTRODUCTION

The Visual Technology Research Simulator (VTRS) Conventional Take Off and Landing (CTOL) simulator utilizes a ten foot radius dome to provide a wide angle viewing screen. Detailed descriptions of the system are given in references 1, 2, and 3 and display geometry shown in Figure 1. The screen has a smooth surface finished with an aluminum paint which has an average gain of 2 from the pilot's viewpoint. The visual displays are provided by two TV projectors which are General Electric Monochrome Light Valves, Model 4PJ 7150A2. The projectors are specified as having a minimum modulated output of 1,000 lumens. They are typically rated with a modulated output of 1,250 lumens. The projectors have a typical contrast ratio of 100:1 with a minimum of 75:1.

The background projector's Field of View (FOV) has an azimuth of 160° and an elevation of 80°. This provides a display area of 345 square feet. The wide angle optics designed by Singer Link have an axial transmission factor of 0.85. This is added to the projector T-6 lens which was slightly modified and designated T-6M.

The target projector FOV has an azimuth of 55°, an elevation of 43° and a diagonal dimension of 66°. This provides a target display area of 73 square feet. The target projector optics incorporate a 10:1 zoom lens (66° diagonal to 6.6° diagonal). Transmission factor of the target projector optics is 0.25. These optics are quite complex and include the T-6M, beam splitter, derotation prism, relay optics, 3 corner reflectors and the zoom lens. The target projector FOV is servo driven in azimuth and elevation and can be dynamically moved to any position within the background FOV.

Screen luminance can be predicted by using the equation:

$$\text{Foot Lamberts} = \frac{\text{Lumens x Transmission Factor x Screen Gain}}{\text{Display Area (Square Feet)}}$$

$$\text{Background Luminance} = \frac{1000 \times 0.85 \times 2}{345} = 4.9 \text{ Foot Lamberts}$$

$$\text{Target Luminance} = \frac{1000 \times 0.25 \times 2}{73} = 6.7 \text{ Foot Lamberts}$$

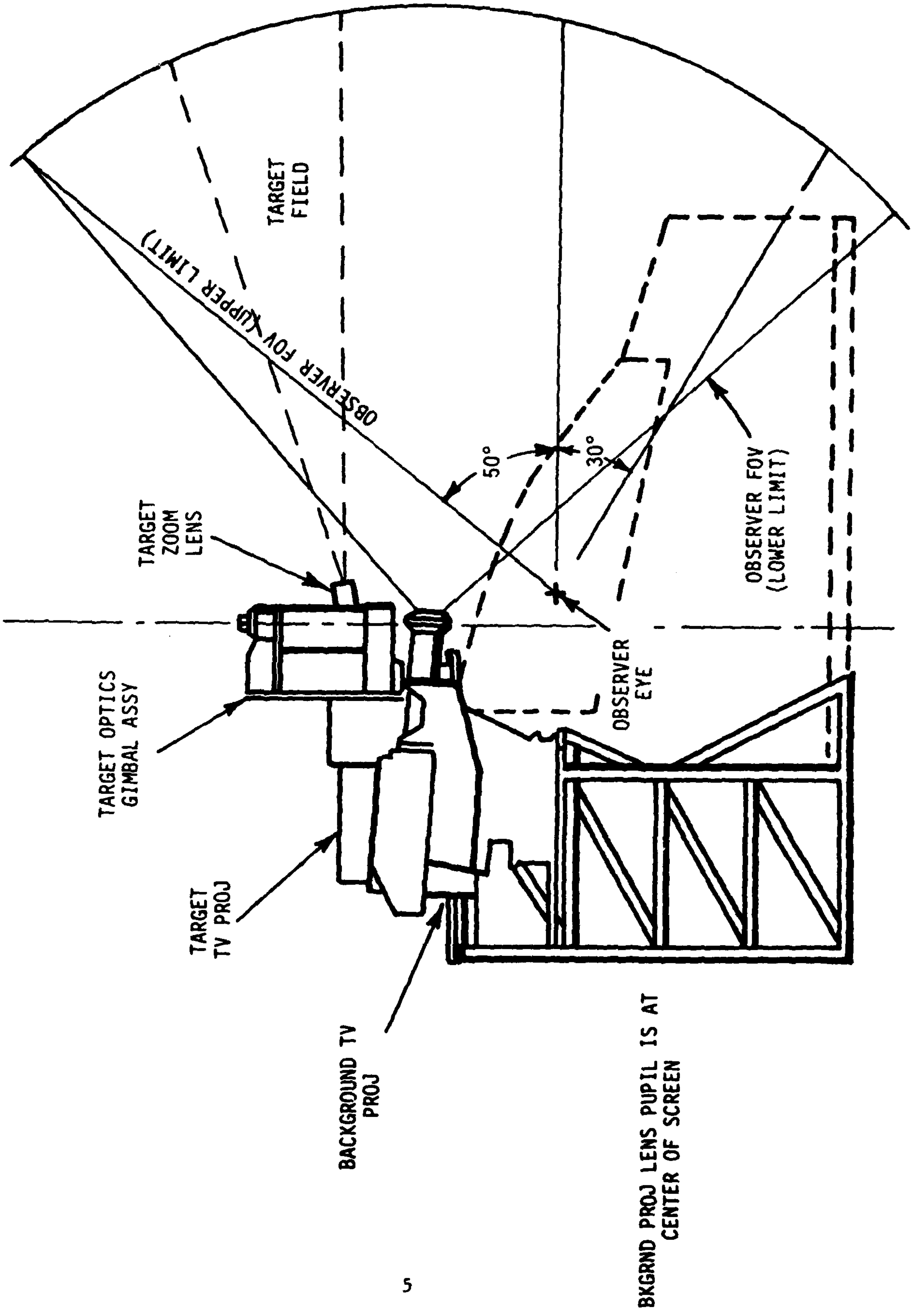


Figure 1. VTRS/CTOL Display Configuration

The target projector optics has a servo operated variable density filter which provides a near constant brightness as the zoom lens FOV varies from 66° to 6.6° diagonally. At 66° the filter attenuates the brightness by 10% and increases attenuation with increasing zoom to hold brightness constant. This filter is also set to a bias level to keep the target projector's dark field from being visible and creating a halo effect around the projected target image.

In order to reduce bleed through of the background image display to the target image display when the two are presented together, a blue filter was placed in series with the background optics. The addition of the filter provided a higher contrast ratio between the background and target image displays. An additional effect of the filter was the pleasing blue tint it gave to the sky and sea background display.

This description of the display system and the measurements reported herein are representative of the VTRS CTOL system during the period of 1978 through 1980. The conversion of the displays to color will change the displays beginning in 1981. A later report will provide data on the color CTOL display.

SECTION II

MEASUREMENT

MEASUREMENT 1, BACKGROUND DISPLAY

Figure 2 shows three plots of brightness measured in foot lamberts in relations to FOV in degrees. Ten shades of grey were displayed across a FOV of 160° in azimuth and 80° in elevation. These shades of grey were the result of ten (10) equal steps of video input to the projector. Curve 1 of Figure 2 depicts the response measured from the pilot's viewpoint. Curve 2 of Figure 2 depicts the same response with the blue background filter inserted.

Curve 3 of Figure 2 shows the response obtained at the center of the FOV by applying all ten shades of grey one at a time in a flat field mode. The background display operating independently has a maximum luminance of 4 foot lamberts and a contrast ratio of 80:1.

MEASUREMENT 2, TARGET DISPLAY

Figure 3 shows the plots of 4 curves which are measured in foot lamberts in relation to the FOV in degrees. Ten shades of grey were displayed across a FOV of 60°. These shades of grey were the result of ten (10) equal steps of video input to the projector. Curve 1 of Figure 3 depicts the response obtained at the pilot's viewpoint. Curve 2 of Figure 3 shows the response measured at the center of the FOV by applying all ten shades of grey one at a time in a flat field mode with a 60° FOV. Curves 3 and 4 depict the same mode measured at 30° and 10° respectively. The target display operating independently has a maximum luminance of 6.4 to 10 foot lamberts depending on FOV and a maximum contrast ratio of 100:1.

MEASUREMENT 3, COMPOSITE DAY DISPLAY

By combining the two displays the VTRS has been able to achieve high fidelity visual simulation in the CTOL carrier landing mode. The two displays provide the pilot trainee a target image that possesses high resolution with excellent detail clarity and realistic dynamic movement coupled with the background image that provides wide angle peripheral scenes.

Figure 4 shows the effects of combining the background and target displays with a CIG video signal rather than the test patterns used in Measurements 1 and 2. Figure 4 presents a view of the carrier on a clear day at 1000' from the ramp. Table 1 provides the measurement of luminance distribution in foot lamberts of significant segments of the composite display. Two quantities are presented for luminance, with a background blue filter, and without. Most experiments were conducted with the filter present. The maximum luminance for this day composite display was 4 foot lamberts with a contrast ratio of 8:1.

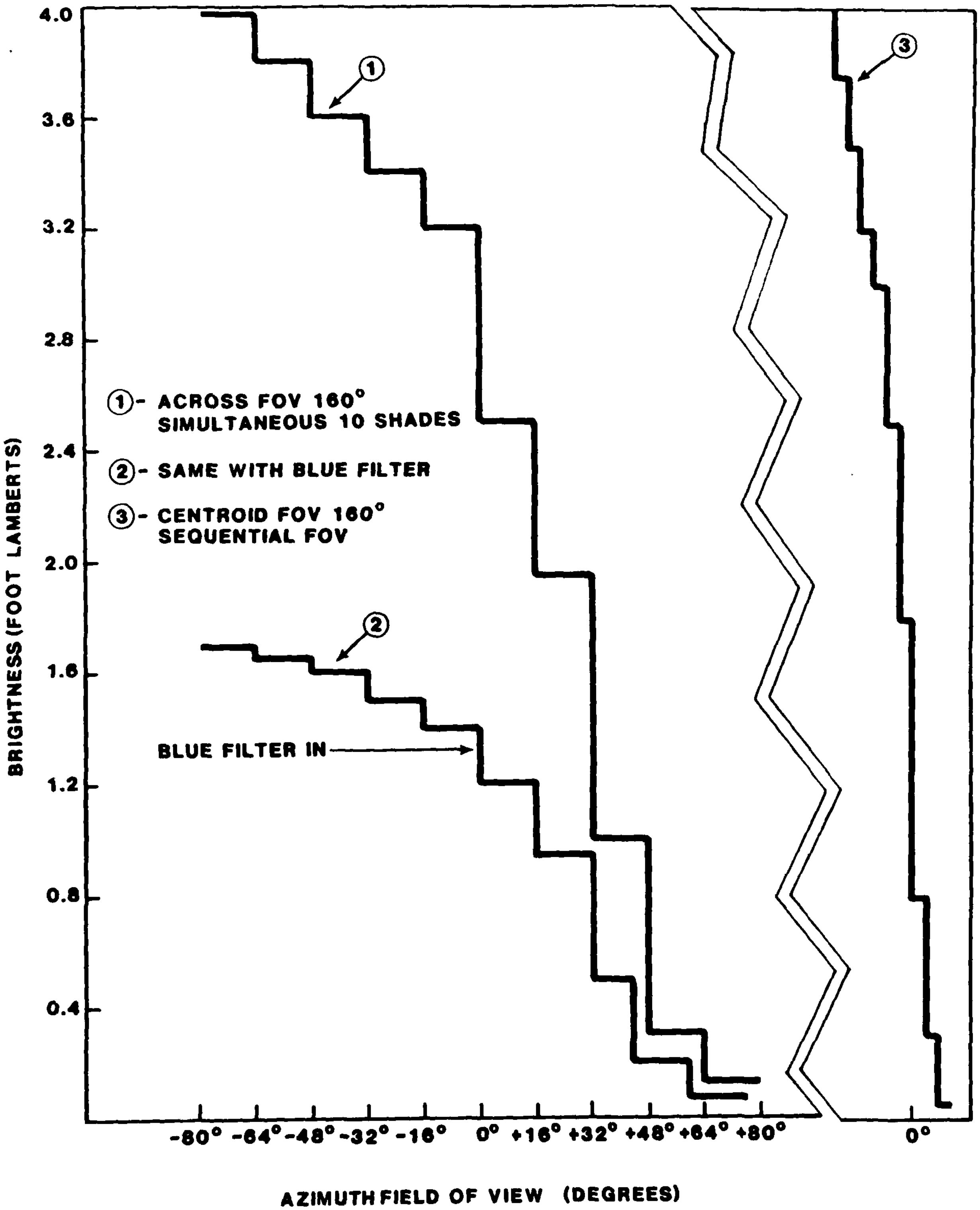


Figure 2. Contrast Test Pattern Brightness Plot of Background Display, CTOL

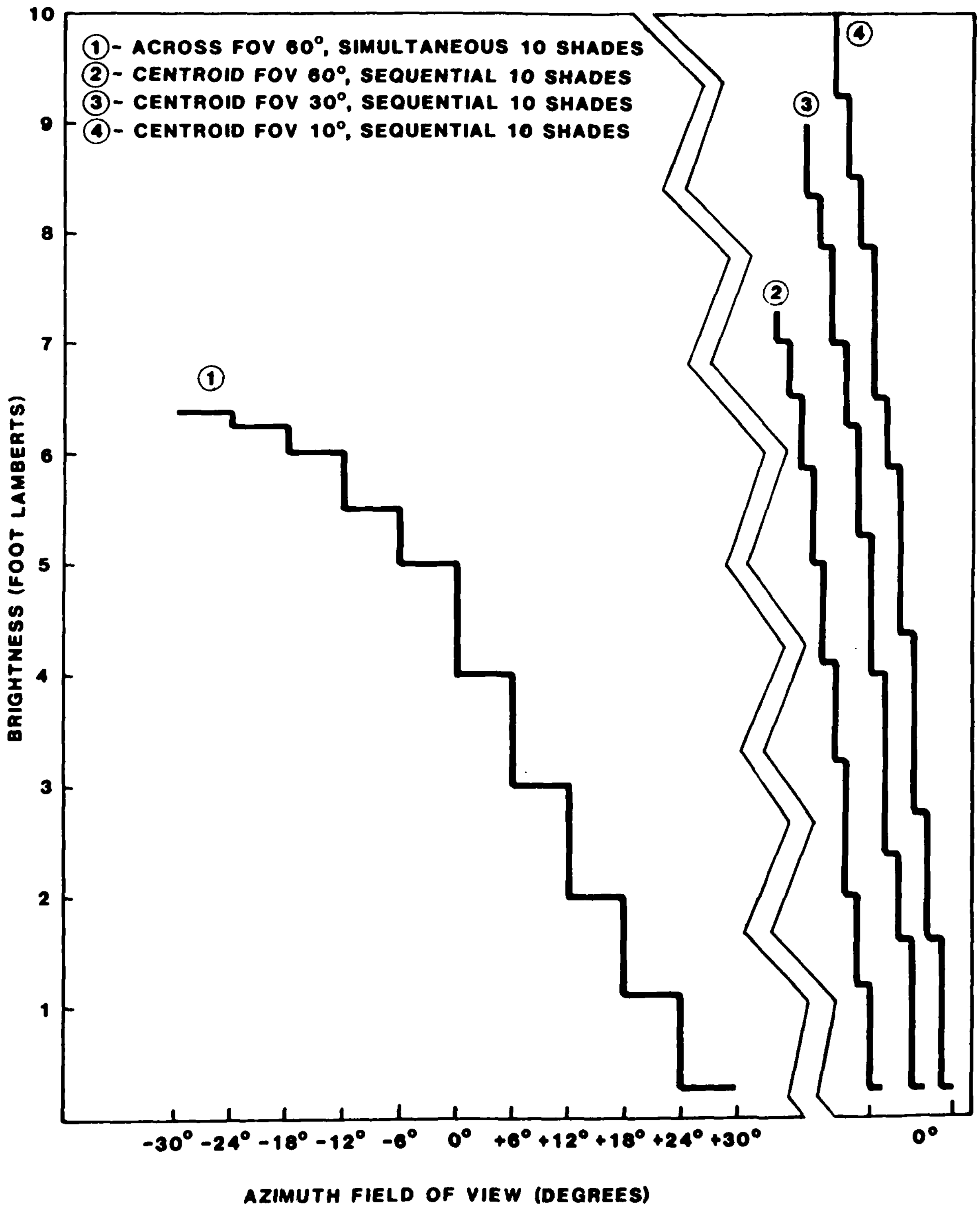


Figure 3. Contrast Test Pattern Brightness Plot of Target Display, CTOL

In these tests the target projector was driven by the Computer Image Generator (CIG) providing a carrier, Fresnel Lens Optical Landing System (FLOLS), and wake image only (no sky or sea). The background projector was driven by a flying spot scanner providing a seascape image and special effects circuitry providing sky, horizon, and seamerge imagery.

TABLE 1. LUMINANCE MEASUREMENTS CTOL DAY CARRIER LANDING DISPLAY FOV (Foot Lamberts)

	ELEMENT	FILTER	NO FILTER
1.	Sky (+30° elevation)	0.85	1.5
2.	Sky (+5° elevation)	0.84	1.6
3.	Sea (-5° elevation)	0.62	1.2
4.	Sea highlight (-15° elevation)	0.66	1.2
5.	Sea (-15° elevation)	0.50	0.98
6.	Carrier ramp (white)	4.0	4.5
7.	Carrier runway lines	3.8	4.2
8.	Carrier runway	2.5	3.5
9.	FLOLS* Meatball**	2.0	2.4
10.	FLOLS Background	0.68	1.3

*Fresnal Lens Optical Landing System. (Standard U.S. Navy carrier optical landing device).

**Meatball is the light source of the FLOLS which the pilot uses for glideslope information in a carrier approach and landing.

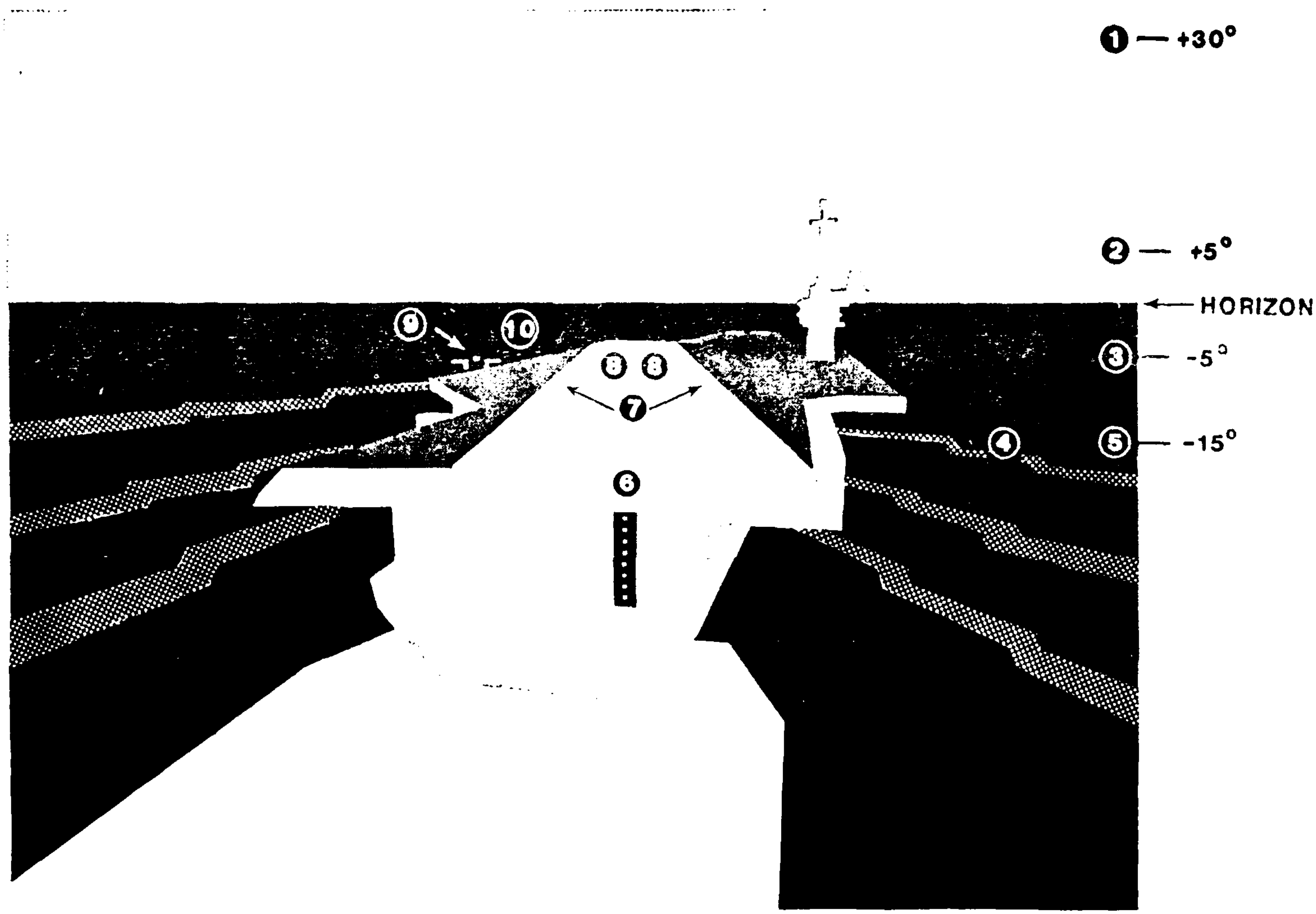
MEASUREMENT 4, COMPOSITE NIGHT DISPLAY

Figure 5 shows the same FOV of the background and target displays at night, 1000' to the ramp. Table 2 provides the luminance distribution in foot lamberts of the composite night display.

TABLE 2. LUMINANCE MEASUREMENTS CTOL NIGHT CARRIER LANDING DISPLAY FOV (Foot Lamberts)

1.	Carrier Deck Runway Lighting	1.5
2.	Carrier Runway Area	0.048
3.	FLOLS Meatball	0.6

Figure 5 also shows the blending of sea and sky background display which highlights the deck lighting and FLOLS at night. The image generation sources for this test were the same as measurement 3 but with a night data base model for a special effects setting. The night display can also be set with no sky or horizon visible. The maximum luminance of this night display was 1.5 foot lamberts and a contrast ratio of 30:1.

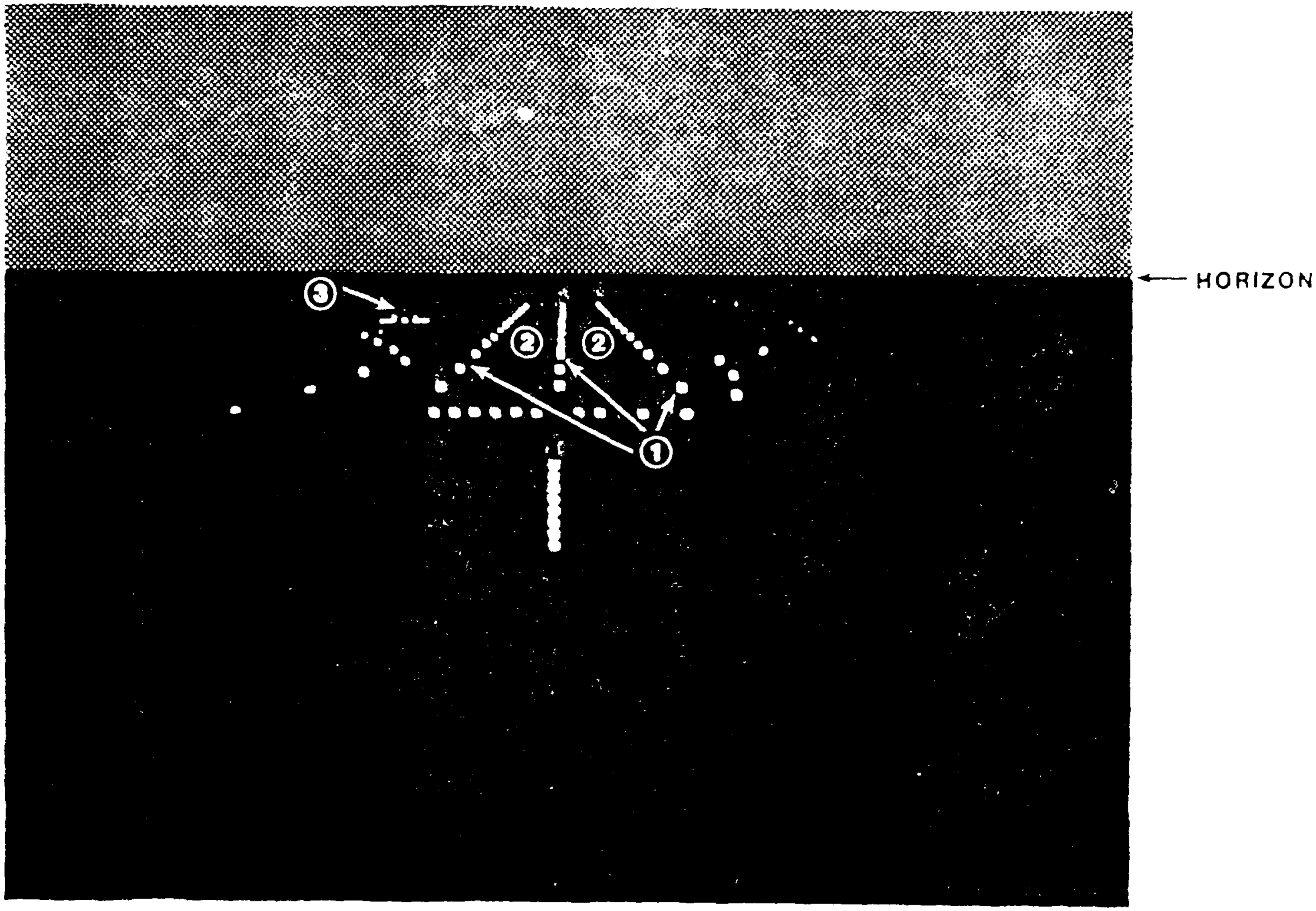


1. SKY (+30° ELEVATION)
2. SKY (+5° ELEVATION)
3. SEA (-5° ELEVATION)
4. SEA HIGHLIGHT (-15° ELEVATION)
5. SEA (-15° ELEVATION)
6. CARRIER RAMP (WHITE)
7. CARRIER RUNWAY LINES
8. CARRIER RUNWAY
9. FLOLS* MEATBALL**
10. FLOLS BACKGROUND

* FRESNAL LENS OPTICAL LANDING SYSTEM. (STANDARD U.S. NAVY CARRIER OPTICAL LANDING DEVICE)

** MEATBALL IS THE LIGHT SOURCE OF THE FLOLS WHICH THE PILOT USES FOR GLIDESLOPE INFORMATION IN A CARRIER APPROACH AND LANDING.

Figure 4. CTOL Day Carrier Landing Display FOV



1. CARRIER DECK RUNWAY LIGHTING
2. CARRIER RUNWAY AREA
3. FLOLS MEATBALL

Figure 5. CTOL Night Carrier Landing Display FOV

SECTION III

CONCLUSION

Luminance measurements of the VTRS CTOL carrier landing display for night and day were made and recorded for future reference. They are representative of monochrome display characteristics used during 1980 carrier landing experiments in VTRS. Measurements 1 and 2 give the maximum capabilities of the target and background displays independently of each other. Measurements 3 and 4 give a balanced capability of the composite display using both displays simultaneously. It can be seen that this balanced composite display does not make maximum use of each display's individual capability. The final composite display luminance levels are tradeoffs to minimize visual distractions due to the TV projector's non-black dark field and the zoom lens induced brightness variation with zoom. The carrier landing day scene had a highlight luminance of 4 foot lamberts and a contrast ratio of 8:1. The carrier landing night scene had a highlight luminance of 1.5 foot lamberts and a contrast ratio of 30:1. The lower day scene contrast is a direct result of cross screen reflectance inside the spherical display where large bright areas such as the sky illuminate and therefore wash out the contrast of the seascope and aircraft carrier image. This same effect extends into dynamic flight in that slight contrast change will occur with changes in aircraft attitude and position which change the ratio of light and dark areas in the overall display.

REFERENCES

Chambers, W. S., AWAVS: An Engineering Simulator for Design of Visual Flight Training Simulators, Journal of Aircraft, Vol. 14, No. 11, November, 1977.

Fisher, R. A. and Lyons, R., AWAVS Trainer Subsystem Design Report, NAVTRAEQUIPCEN Technical Report No. 75-C-0009-13.

Kashork, E. F. and Turner, J. A., AWAVS: Visual System Performance, SPIE Vol. 162 Visual Simulation and Realism, 1978.

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